A Newsletter of the Local Technical Assistance Program (LTAP)

T2 Bulletin

Issue 66, Spring 2000

Mill Creek Concrete Arch Culvert Installation

Pend Oreille County, Washington

Walt Olsen, PE, County Engineer

On the afternoon of May 26, 1998, areas of Pend Oreille County received rainfall amounts in the range of 2.5 inches to 3.5 inches over a 24-hour period, but mostly in an 8-hour period from 4 p.m. to 12 midnight. This resulted in some small stream flooding in the mid-county areas that caused a complete washout of the Le Clerc North Road, approximately 13.3 miles north of the town of Usk.

The Mill Creek washout occurred when heavy runoff and snow melt from a largely logged off drainage basin moved a substantial amount of 2′ - 3′ minus boulders into the inlet area of the culverts, plugging the double 48-inch pipes. Efforts to correct the problem in 1997 were restricted by the denial of a Hydraulics Permit to remove bed load from the inlet area.

The Le Clerc North Road is the only major collector route on the east side of the Pend Oreille River. The detour around this washout was over 100 miles. The roadway is completely washed out approximately 3 feet deep and 12 feet wide for the full width of the road, and the asphalt surface is under-

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Washington State Technology Transfer Center

WST2 HIGHWAYS & LOCAL PROGRAMS SERVICE CENTER

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www.wsdot.wa.gov/TA/T2Center/T2hp.htm

mined for about 200 feet south of the creek. Water overfilled the ditch on the east side of the road and washed down the shoulder line for nearly one-half mile to a smaller culvert. Efforts to temporarily reset the existing culverts failed when the pipes "floated" during excavation. Inspection revealed that extensive corrosion had taken place due to the loss of galvanizing materials by bed load movement.

After meeting with Don Hendricks from WSDOT's Eastern Region H&LP Office and Shawn Cutting from FHWA on June 3, 1998, Pend Oreille County began working to address betterment and proprietary justifications. The betterment analysis of the options was conducted in mid-June and presented to FHWA on June 18, 1998.

Increased Waterway Opening

The Mill Creek drainage had been heavily logged over the last 15 years and reforestation efforts have been successful in re-establishing trees in the area. However, the young small trees did not use the same amount of water that the large, older trees used in the past. Runoffs were significantly increased in this basin as an estimated 60 to 70 percent of the 13,700 acre drainage had been logged. An analysis of the drainage area using the USGS Regression Equation for Region 8 and the nomograph for inlet control of steel culverts was used. The nomograph indicated that the two 48-inch culverts could not handle the flow (Q) for a two-year, 24-hour event (65 cfs x 2 pipe = 130 cfs versus Q2 = 161 cfs). The nomograph showed that in order to flow the 100 year event (Q100) + 15 percent for stream embedment, a structural plate culvert 14 feet 1 inch span by 8 feet 9 inch rise would be required. However, the span of the culvert would still have been too narrow to handle much of the wood debris which comes down Mill Creek in storm events.

The need for a larger hydraulic opening at the mouth of this basin was clear. Increased stream bed load and wood debris from the logging activity had restricted the waterway and caused overtopping of the roadway during storm events during the last three years. A reoccurrence of these events was quite possible; the May 27 event was believed to be somewhere between the 10 and 25 year events. A structure that clear spans the stream channel, allowing drift material to pass unimpeded, reducing stream velocities in the area and reducing the risk of overtopping the roadway was definitely justified.

Improved Fisheries Resources

The recent Endangered Species Act listing of Bull Trout (Salvelinus confluentus) and depressed populations of Westslope Cutthroat Trout (Salmo clarki) by federal regulatory agencies was addressed in all options being considered for this project. Tribal fisheries specialists working with the Kalispel Tribe of Indians had identified Mill Creek as a stream where enhancement opportunities should be exploited. Impacts to tribal fisheries could be reduced significantly by replacing the double culvert system with a clear span structure. Reductions in stream velocity, removal of a fish passage barrier to upstream reaches of Mill Creek, and a return to a more natural stable stream channel in this area could be accomplished by replacement with a clear span structure.

Footing Design

The Mill Creek bridge site was composed of consolidated glacial and alluvial outwash ranging in size from #200 to 3' plus boulders. It had a very low void ratio and high density due to the high compaction of the area under the roadway. This type of soil condition was ideal for the use of a spread footing which could be precast and set quickly with minor excavation. The CON-SPAN precast concrete modular arch structure offered this method for speed of construction. Native riprap materials were utilized to prevent any possible scouring. Typical bridge foundations

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using piling or cast-in-place footings would have added days to construction and increased delays and costs to the traveling public. In addition, no large quantities of uncured concrete could be used within the ordinary high water mark of the stream in accordance with the conditions of the WSDFW Hydraulic Permit Approval issued to Pend Oreille County.

Wingwall and Headwall Design

The use of precast wingwalls and headwalls with precast integral anchoring systems would save weeks of construction time and allow the back-filling operation to proceed immediately after setting the last of the units instead of waiting for curing periods. Cast-in place members could potentially be a source of chemical leaching if a release of fresh concrete were to occur during a pour. Again, the WSDFW Hydraulic Permit Approval issued to Pend Oreille County did not allow uncured concrete to come into contact with state waters. The recent Endangered Species Act listing of Bull Trout (Salvelinus confluentus) and depressed populations of Westslope Cutthroat Trout (Salmo clarki) by federal regulatory agencies had to be addressed in all options being considered for this project.

Substructure and Superstructure Design

The substructure and superstructure of the CON-SPAN precast concrete modular arch structure are manufactured as a single unit under strict plant production guidelines with tight tolerances for quality control. This production method allows for a much quicker construction sequence with a structure capable of handling heavy loads at low stress levels. In addition, the units are not tied together with welded steel tie plates which require the use of grouted keyways for load transfer, reducing the possibilities of longitudinal pavement cracking over the deck joints where heavy truck traffic is present. Bearing pads are used to support the structure on the footing and are grouted into place with a fast set grout to allow for immediate backfill. No concrete deck is exposed to the traffic load and the curved design of the arch sheds water and roadway chemicals, reducing the possibilities of deck delamination and spalling maintenance costs associated with more traditional bridge designs. The use of native backfill materials available close to the site further reduced total cost of construction and allowed for asphalt running surfaces and precast guardrail elements to be used. While the initial installation costs of a precast concrete modular arch structure were higher, the reduced construction time and maintenance costs of this type of structure represent considerable savings over the life span of the structure.

Economics of Options

An actual economic analysis of the options had not been performed beyond the overview stage, but several points were clear. While the initial installation costs of a precast concrete modular structure are higher, the life span is three times as long and the maintenance costs were usually less than one third of those of metal culvert pipe. The installation time and availability of the arch structure made it an attractive and cost effective alternative to a standard bridge constructed with wingwalls. The following table depicts the major decision making criteria and the cost differentials found for this area:

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Corrugated Metal Pipe Culvert - Structural Plate or Standard Round

Estimated Life Span:	30 years
Installation Time:	20 days (includes walls and backfill)
Delivery Schedule:	4 to 6 weeks from order date
Installation Costs:	**$57,050**
Materials costs:	$29,550 (includes pipe and concrete for head and wing walls)
Equipment costs:	$12,500 (including crane costs)
Labor costs:	$15,000 (prevailing wages)
Annual Maintenance Cost:	$1,200 (estimated two events requiring maintenance)
Advantages:	Common type installation Locally available Ease of installation
Disadvantages:	Stream bed disturbance Problems with bed load and debris passage Long construction period Longer traffic delays Not easily repaired or extended Not hydraulically adequate if blocked by debris Possible concrete spill into sensitive waters

Standard Bridge Construction with Wingwalls

Estimated Life Span:	75 years
InstallationTime:	30 days (includes walls and backfill)
Delivery Schedule:	6 to 8 weeks from order date
Installation Costs:	**$93,000**
Materials costs:	$58,000 (includes sub/superstructure and erection)
Equipment costs:	$15,000 (including backfill costs)
Labor costs:	$20,000 (prevailing wages)
Annual Maintenance Cost:	$450 (estimated inspection and repair costs every two years)
Advantages:	Common type installation Locally available WSDOT Approved
Disadvantages:	Unavailable until September 1 (earliest) Long construction period Longer traffic delays Higher annual maintenance costs Not easily repaired or extended Possible concrete spill into sensitive waters

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Precast Concrete Modular Structure - Arch Culvert

Estimated Life Span:	100 years
Installation Time:	5 days (includes walls and backfill)
Delivery Schedule:	4 to 5 weeks from order date
Installation Costs:	**$108,000**
Materials costs:	$80,000 (includes head and wing walls)
Equipment costs:	$18,000 (including crane costs)
Labor costs:	$10,000 (prevailing wages)
Annual Maintenance Cost:	$250 (estimated inspection and repair costs every two years)
Advantages:	Available July 20 (earliest) Longer life span Shorter construction time and traffic delays No work directly in stream Quick installation Reduced bridge icing problems High strength-to-weight ratio Larger hydraulic opening Easier repairs or extension WSDOT Approved
Disadvantages:	Higher initial installation cost Suppliers out of area Requires more skilled labor force

It became apparent that a clear span structure was the best option for the reconstruction and could be justified on the basis of economy, suitability, engineering feasibility, and reasonable assurance of success in correcting the problem of overtopping the culverts and roadway at the Mill Creek site. The decision to replace the structure with an open bottom, concrete precast product was made based upon hydraulics and fisheries concerns as well as maintenance considerations. A proprietary analysis of those options was required for replacement of the double 48-inch culverts with a CON-SPAN precast concrete modular arch structure to be provided by CSR Hydro Conduit of Tualatin, Oregon. Pend Oreille County requested FHWA and CRAB to consider funding the project under the Emergency Relief and Emergency Project statutes. Restoration work was estimated at two weeks time and a cost of $200,000 for replacement of the culverts with a precast modular structure.

The problem of maintaining traffic without a 104-mile detour route led to a cooperative effort between Pend Oreille County and Idaho Forest Industries. IFI made one of their railroad flatcar bridges available to the county for no charge and a small works contractor installed the structure on June 2, 1998. Traffic was restricted to one lane and 5 mph. The temporary bridge was needed at another location and had to be moved as quickly as possible. The replacement structure had to be constructed quickly with a minimum traffic detour time.

Engineering support for this project was provided by the CON-SPAN design team in Dayton, Ohio. Preliminary site drawings were forwarded to the manufacturer and an authorization for production was sent. This project had to proceed quickly in order to finish while weather conditions were favorable and the temporary bridge was available. Faxed and e-mailed drawings helped everyone on the project keep up on the progress. WSDOT staff in the Vancouver office worked with us to assure quality control at the plant.

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Meanwhile, county engineering staff set about the chore of finding enough manpower and equipment to do the job. Most of the larger contractors were in the middle of construction projects and would not be able to fit in with our tight time line. County crews had shown interest in doing the work but lacked some key pieces of equipment. The decision to use small works contractors to perform services that Pend Oreille County did not have equipment to accomplish while using county personnel for the skilled labor positions was made in the first weeks after the washout. Copies of the construction plans were reviewed by the crew and two meetings on-site with key personnel were held to raise our confidence level. To alert travelers to the road closures, notices were posted in the local newspaper and radio spots were broadcast for a week, beginning on August 10.

On the morning of August 17, 1998, the roadway was closed for the installation of the permanent structure. Working with small works contractors Knoles Logging and Ken Maupin Logging, county crews removed the temporary structure. Excavation for the precast footings of the new precast concrete modular arch culvert was completed the first day of the closure. Hite Crane's 70-ton mobile crane and crew arrived on site at first light on August 18, as well as the precast footing units, trucked to the job by Rexius Forest Products. These were set in place, ready to accept the arch units, by the end of the second day. The precast modular arch culverts, supplied by CSR Hydro Conduit of Tualatin, Oregon, were delivered to the site on the morning of August 19. The actual setting time for the six units was less than two and a half hours! County crews began the job of applying the mastic seals, wing walls and anchors, and placing the grout in the keyways immediately after the units were in place. That job was substantially completed by the end of the third closure day. Work began on the backfilling of the arch sections and wingwalls on the morning of August 20, using native rock materials from a pit site owned by the Stimson Lumber Company. The embankment operation went smoothly enough that traffic could use the structure by 2 p.m. the same afternoon. Final top course and guardrail placement finished out the project by noon on August 21, the fifth day. The pre-final cost of the project was $171,230.86 before paving with hot mix asphalt. Paving was completed during the summer of 1999.

We have since completed a second installation of the same system on another fish bearing stream on the Kalispel Indian Reservation within the same time frame of a five-day closure and comparable costs per unit-foot. While costs for initial installation may be somewhat higher, the long life span and improved fish passage make these culvert projects attractive and practical solutions for both resource agencies and local road engineers and managers.

Walt Olsen is the County Engineer for Pend Oreille County. He has been an active member of the WST2 Advisory Committee since 1994 and has served as the Chair since 1996.

Walt graduated from Washington State University in 1978 with a degree in Forest Management. He worked in the forest industry for five years. In 1984 he started work with Adams County, where he gained experience as a survey crew member and as an operations technician. He received his professional license in 1992 and worked his way up through the ranks to become the County Engineer. In 1995, Walt became the County Engineer for Pend Oreille County, where he currently works.

Environmental Issues, Endangered Species Act, and Related Legal Issues

By Al King, P.E., WSDOT-Highways & Local Programs Service Center

The 1999 salmon listings under the Endangered Species Act (ESA) have generated a considerable amount of concern from local agencies who are struggling to comply, and who strongly desire to do so while minimizing the risk of legal challenges and lawsuits. Virtually all agree that litigation is an expensive, time consuming, and generally undesirable method of achieving desirable ends. At the same time, legal expertise in the area of ESA is sometimes limited at the local agencies. As a result of these concerns, we have received a number of inquiries at Highways & Local Programs about the possibility of providing legal expertise and information for local agencies.

We have discussed how we might provide such assistance to the agencies with the Attorney General's Office, and our ability to assist in this area is limited. The AG represents directly the state agencies who are charged with regulating many of the areas encompassed by the ESA. A direct conflict would occur as a result of trying to, in effect, represent the local agencies as well.

A more appropriate role is one of education and providing general information such as court decisions and such general briefing papers as may be open for publication (as opposed to those which may reflect a specific case in litigation or other legal advice and thus protected by an Attorney/Client relationship.)

In an effort to assist in this manner, the AG's Office has agreed to provide that type of information. Highways & Local Programs will make that information available through our Internet Web pages.

H&LP plans to have updates on the 25th of each month as new information is acquired and will advise you of its availability through an email notification. If you would like to be placed on that notification list, please send an email message to Al King at WSDOT H&LP requesting addition to the "Environmental Legal Issues List" at: ***KingA@wsdot.wa.gov.***

Paul Sachs Expands His Horizons

Taking advantage of a new career opportunity, Paul Sachs, Pavement Technology Engineer, has left the Technology Transfer Center to open a consulting office in Tacoma. Over the past 5 and one-half years Paul has been a valuable member to both the WST2 Center and the former Management System Office. All his efforts have been greatly appreciated. Although his sense of humor and technical expertise will be greatly missed within the Center, we look forward to his continued participation within Washington's pavement management community.

We wish Paul the best in his new endeavor.

What is WASSP Up To?

Wil Brannon, Traffic Operations Supervisor, Pierce County

The Washington Alliance of Sign and Striping Personnel (WASSP) has committed itself to the Road and Street School held annually on the eastside of the mountains in October and the westside in December. Washington State University Conferences and Institutions will be the organizational functions and facilities with WASSP providing the conference topics and speakers.

This a great partnership since it frees WASSP to focus on the information rather the getting tied up with logistics.

There are some educational conferences coming up where some of the agendas will be items of interest to the WASSP members. The first one is the first "Pacific Northwest Transportation Technology Expo" at the Grant County Fairgrounds in Moses Lake on September 12-14. This will be a great opportunity to see displays and demonstrations of new modifications or techniques used by public agencies. And it is all free.

Next will be the "Road and Street Maintenance Supervisors' School" in Spokane on October 2-5 and in Tacoma on December 5-8. The WASSP group will hold a "Traffic Solutions "pre-conference workshop with one-half day dedicated to the topic of sign vandalism and one-half day on the subject of improvements made in the application and handling of waterborne paint.

On March 6-8, 2001 the Road Builder's Clinic will present a program entitled "Innovative Solutions for the 21st Century." Again, WASSP members will take part in topics such as Road Rage, FHWA status of minimum level of reflectively for signs, video detection at intersections and continuing updates on sign vandalism.

Hopefully, you will mark your calendars and we will see each of you at one or more of these events. For information on the Road and Street Maintenance Supervisors' School and the Road Builders' Clinic, call WSU, Conferences & Professional Programs (509-335-4194) or Wil Brannon(253-531-6990). For the Pacific Northwest Transportation Technology Expo contact WST2 Center Director Dan Sunde (360-705-7390) or WSDOT Maintenance Superintendent Clay Wilcox (360-705-7861).

Lincoln County Exchanges Expertise With Baltic States

Source: Bob Breshears, P.E., Director/County Engineer, Lincoln County

Bob Breshears, P.E., Public Works Director/County Engineer, Lincoln County had the opportunity to participate as a member of Pavement Quality Management III, an international team that made a series of presentations to the Baltic countries of Estonia, Latvia, and Lithuania on pavements. Bob was part of the third in a series of seminars, the Pavement Quality Management Series, developed in a cooperative effort between the US Federal Highway Administration (FHWA) and the Finnish National Road Administration (FINNRA). Their mission was to assist the Baltic States in technology transfer. This particular seminar was presented over a two week period from June 10 to June 25, 1999. It focused on maintenance of light pavements on low volume and gravel roads.

Bob was selected because of his considerable experience with gravel roads and light pavements and his reputation for having the roads in his county well maintained. Lincoln County is a rural county here in Washington with most of its miles unpaved and gravel.

Bob was joined by Mr. Pekka Viertola, Assistant Manager of the Virrat Maintenance Area, FINNRA. Mr. Viertola also has considerable experience in dealing with the gravel roads in his maintenance area under the "self-directed work team" approach currently used in the operations activities of FINNRA.

The "self-directed work team" approach is a maintenance process in which the crews of maintenance areas are required to maintain their paved and unpaved roads to established agency standards by bidding their maintenance work to a regional "orderer." They are required then to do that work within the bid amount and established agency standards. The maintenance areas are required to maintain aggregate surfaced roads to an specific smooth, dustless condition.

Mr. Viertola has spent a great amount of time in Latvia working with the Road Administration and was a member of the previous team, Pavement Quality Management II, in 1997.

Janne Juntunen, Project Assistant (Quality Engineer), FINNRA and Dan Baker, Summer Intern with FINNRA from Great Falls, Montana and a recent graduate of Montana State University, accompanied the presenters acting as liaisons and coordinating the transportation and sundry other details.

Over the extent of the trip the speakers presented a variety of topics focused in areas of interest selected by the Baltic hosts with plenty of opportunity for open discussion and questions. Bob made the following presentations during this series:

- "Drainage, Drainage, DRAINAGE"
- "Light Pavements on Low Volume Roads" (with Pekka Viertola, FINNRA)
- "Functional Classification of Roads and Design Standards"
- "Light Pavements on Low Volume Roads"
- "Gravel Road Maintenance… What… and When"

Other Topics presented by Pekka Viertola included:

- "Gravel Road Maintenance Standards in Finland"
- "Finnish Experiences on Soft Asphalt Pavements on Low-Volume Roads"
- "Spring Repairing of Gravel Roads: Dust Binding"

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As is often the case in trying to communicate with students in other countries, the language barrier presented a problem at times by slowing exchanges to allow for translation. This resulted in shortening some sessions to fit within time constraints and limited discussion with some audiences. Overall, the sessions were rewarding with several having lively interaction.

▲ **Wine Cellar Conf. Center, Estonia, first seminar**

Over the curse of the tour Bob and the rest of the team spoke to a wide variety of audiences and had the opportunity to see and observe the differences in and challenges facing the Baltic countries. The first seminar was held at the Heimtali Wine Cellar Conference Center in Estonia approximately 6 kilometers south of Viljandi. The participants were managers of the Technical Center of the Estonian Road Administration and managers of Road Offices in Estonia.

▲ **Port of Riga, Latvia, second and third siminar**

The second seminar was one of two presented in Latvia. It was given to individuals who actually maintained the low volume roads in the field for the Latvian Road Administration (LRA).

The third was given to employees of the LRA Regional Offices, who plan and schedule work on the roads, inspect and accept completed projects, and maintain detailed inventories of the roads and conditions.

The last seminar of the Pavement Quality Management III series was held in the Transport and Road Research Institute in Kaunas, Lithuania. Participants formed a very diverse group with technical directors from ten State Regional road enterprises, some individuals from the Lithuanian Road Administration, one representative from each of five private road companies, and two representatives from the Vilnius Technical University.

While in Latvia, Bob and the rest of the team were also able to visit the Latvian Road Administration Headquarters where he was given a brief tour by Mauris Alksnis, Head of Works Supervision Department. They also received a quick tour of the Materials Testing facility at the Autoce·u izp'te, the regional transportation department headquarters, led by the Director Guna Skangale. The Facility is in the process of upgrading all of their testing equipment from the old Russian equipment to the latest, state of the art equipment. The most significant difficulty currently facing the Road Administration is being confident in the test results as the technicians learn to use the new instruments and at the same time they move from GOST Specifications to European standards.

The team was also able to observe a Latvian overlay project being constructed on Via Baltica E67, the main highway that runs from Tallinn, Estonia, through the Baltic States, then connects to the main highway system of mid-Europe. The team made several observations concerning the construction methods on this project:

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- the hand applied tack coat,
- the mix that was being laid down, and
- the compactive effort being made on the new overlay.

The tack coat applied in front of the paving machine displayed the pattern indicative of hand application. There was no uniformity of the application and the pattern looked as if it had been done with a wand of some type (hand snivey).

The actual mix, after the paver, appeared to be comprised of very fine aggregate. It was a significantly different texture than one would expect from a well designed ACP overlay. Pekka indicated that the aggregate available to the Latvians was very sandy with few particles of any size.

▲ **Downtown Kaunas, Lithuania, fourth seminar**

The compactive effort being done on this overlay was excessive. The team observed at least five rollers on the overlay following the paver. Bob noted that in view of the compactive effort the new overlay would be distressed before any traffic uses it. Pekka stated that when he was in Latvia several years previously he observed the same problem. He also indicated that their production rate for the asphalt was about 100 tons per day.

Traveling out of Latvia and into Lithuania, Bob and the team continued to observe the remnants left behind by the Soviet occupation.

In Lithuania the team was taken on a field trip to a project where the Lithuanians were stabilizing a gravel road in preparation of placing an ACP mat. They were using foamed asphalt and cement, processing the materials with a recycler and then compacting the processed roadway section with a combination steel drum and pneumatic tired roller. Bob queried the Lithuanians in regard to the final processing after the full roadway surface had been treated. They indicated that a motor grader and vibratory roller do the final processing. The production rate for the process was given as 1 km per day.

Upon arrival at the job site the team examined what appeared to be the previous days work. The road surface was well compacted and very stable. The only evidence of the processing was a bit of excess cement at the beginning of the section. Other than that, it appeared to be ready for pavement.

In reviewing the trip, Bob noted that each of these countries has a daunting task ahead of them as they develop maintenance and construction programs in a changing environment, but they are approaching it with enthusiasm and energy. The partnering and technology exchange with FINNRA and FHWA is evidence of their willingness to learn about other ways of performing the work.

Pacific Northwest Transportation Technology Expo ~ 2000

Bring Your Hard Hat and Vest!

Tired of just reading about it?! Would you like to get your hands on it, kick the tires, and watch it work?! Then plan to attend the first technology exposition focused solely on presenting the latest technology in transportation maintenance and operations to the public agencies in the Pacific Northwest. The expo is co-sponsored by the WSDOT-Field Operations Service Center, Washington State Technology Transfer Center, and FHWA to present you the most current technology targeting the areas identified by the Pacific Northwest agencies.

Come and see three days of demonstrations showing the latest technologies that can make your work easier, more effective, and more efficient. Judge for yourself their usefulness and effectiveness.

See first hand the innovative ideas to save money, improve performance, and reduce labor developed and implemented by your peers. Play with their inventions, see how they work, and get ideas on how you can use or improve on them. Talk with the inventors and learn how they made them so you can do it yourself.

See how current research projects can help you do your work better with practical information you can apply today.

See dozens of displays of the latest tools, materials, and services to make your maintenance and operations dollars go farther.

When:
September 12-14, 2000

Where:
Grant County Fairgrounds, Moses Lake, Washington

How Much: Free!!!

Who should attend:
All Engineers, Superintendents, Supervisors, and Technicians involved with transportation construction, maintenance, and operations.

For further information and to reserve a site, Please contact Kelly Newell Conference Coordinator at (509) 335-4247 or knewell@wsu.edu

Rehabilitation of Rural Roads With Cement Treated Base

By: Phillip J. Barto, PE, Maintenance Engineer, Spokane County
(Reprinted from Proceedings to the 51st Annual Road Builder's Clinic, Coeur 'd Alene, ID, March 7-9, 2000)

About 60 percent of the rural paved roads in Spokane County evolved from their beginning as a buggy track. In the late 1940s, the county set a goal to hard surface all roads. Every year they allocated money to apply Bituminous Surface Treatments (BST) to several miles of road. This continued until the 1970s when the oil embargo increased costs to the point that it was no longer economically feasible. For the most part, little engineering was done on these projects. Most of the roads were constructed only 21 feet wide. Even worse, most of the roads used too little gravel under the pavement.

About three years ago, Spokane County developed an integrated pavement management program. Our technicians are providing not only the mandated pavement information for the County Arterial Road System, but are developing and prioritizing multi-year lists of roads for reconstruction, overlays, and chip seals. Ultimately they will begin to manage other maintenance actions such as base failure repairs and crack filling. The current program is developed as a three-year plan and it is used to plan economical rock crushing projects ensuring that the crushed rock is located as close as possible to the road projects planned for those years.

Pavement maintenance costs are extremely high on these poorly constructed roads. Public pressures would not allow the cost-effective and expedient process of pulverizing the roads and returning them to a gravel surface. The standard treatment is to blade patch approximately 250 tons per mile of hot or cold mixed asphalt and chip seal. Although the maintenance costs are high, the roadway surface is acceptable to the public. Because the roads still retain a deficient structure section, they all have load restrictions for an extended period of time every spring. The restrictions stop all business that relies on truck transportation over these routes. Many of the roads have low traffic volumes, and it is probably more cost effective to continue with the high maintenance costs than it is to invest money to reconstruct to today's standards. However, some of the roads are rural truck routes and it would be advantageous to reconstruct those into all weather roads.

▲ **Original road condition**

We have been looking for an economical way to reconstruct these haul roads into all weather roads for some time. In 1999, two possible roads came up on the 3-year chip seal plan that we thought were candidates for this program. We decided that they would be good locations to try a cold in-place recycle into Cement Treated Base (CTB), or more correctly, Soil Cement. The advantages, as we saw it, were that the CTB would provide a much higher load carrying capacity than we could ever achieve using a gravel structure section. The process would also correct the many subgrade problems on these roads. Asphaltic Concrete Pavement use on these roads was determined to be cost prohibitive because of the high production costs and the high transportation

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▲ **CMI RS650 pulverizing the pavement**

cost associated with the long haul distance from the local asphalt plants. Whatever we did, the surface would end up as BST, which adds little strength.

Another advantage of the CTB is that we can pulverize the existing surface and mix an 8-inch CTB section without significantly changing the profile elevation. Because of the in-slopes, the road narrows as the profile elevation increases. It is usually necessary to widen the road by building expensive sliver fills if the profile elevation increases too much. If we had chosen to pulverize the surface and add a gravel shim, the road would have narrowed too much. In fact, we thought that if we used CTB we could squeeze out a little extra width on these roads and end up with a more acceptable 24-foot wide road.

The best soil type for soil cement seems to be a well graded, sandy, gravely material with 10 to 35 percent non-plastic fines. It takes the least quantity of cement and it is easy to mix. Tests indicated that CTB would work well on the material in these roads. Spokane County found that 2 percent cement gave a compressive strength of 250 psi, 4 percent gave 430 psi, and 6 percent gave 600 psi. Although CTB with 6 percent, 7 percent, and even 8 percent cement, using a well-graded crushed aggregate, is sometimes used under concrete pavement, we concluded that this was not a good idea under flexible pavement. High cement content forms a rigid slab. With frost heave and other deformations the slab can crack just like a crack in concrete. When this happens, the crack reflects through the flexible pavement. A less rigid slab seems to provide a good load bearing capacity. The cracks are much more frequent, and therefore much smaller, so it forms a matrix with plenty of internal friction and no reflective cracks. The county decided to use 4 percent cement in an 8-inch slab.

The CTB project was set up as a joint venture between a contractor and county forces. The contractor was required to pulverize the existing pavement to a depth of 8 inches, furnish and mix 4 percent Type II Portland cement with the material. The specification required that the contractor use a CMI RS 500, or larger reclaimer stabilizer. This is a 60,000 pound, 535 horsepower machine. The cement spreader to be used was required to

▲ **Adding the concrete treated base**

▲ **Rolling the concrete treated base**

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have a weigh scale, a foot per minute gauge, and a vane type cement feeder to control the cement content properly. Spokane County was to furnish traffic control and any watering and grading necessary to maintain traffic through the project. The county would also furnish water trucks for mixing that would be compatible with the water hook-ups on the contractor's mixer. It was also the county's responsibility to lay the material to grade, compact to 95 percent of maximum density (based on the AASHTO T 180-90 test procedure), maintain surface moisture, and provide a curing seal over the CTB. The bid was awarded to the Porter W. Yett Company in the amount of $154,649 for 4.44 mile of 24-foot wide roadway.

and another to help with moisture control and to replenish the mixing supply trucks if necessary. An 84-inch single drum vibratory roller was used for compaction.

The mixing was done in 1,000-foot stretches utilizing two mixer passes in order to mix full width. The reason for mixing the short runs was to enable us to mix it, lay it, and compact it before it began to set. The work was done in late July, and the weather was hot, dry, and windy. Of course, the disadvantages to mixing in short runs are that it slows production, and there is always an irregularity at the joint. The material was compacted to 95 percent of maximum density.

Summary of Costs

Description	Cost Per Mile
Contract Cost (Pulverize, furnish cement, and mix)	$34,200
County Costs (Pulverize, mix, and lay)	$ 6,400
County Costs (Place and compact gravel shim)	$15,300
Subtotal	**$55,900**
County Costs (Two shot bituminous surface treatment)	$20,500
County Costs (Engineering costs)	$ 2,300
County Costs (Third shot bituminous surface treatment in 2000)	$12,000
Total	**$90,700**

The contractor used equipment that exceeded the specifications. They used a CMI RS 650 reclaimer stabilizer, which is a 64,500 pound machine with 650 horsepower. Pulverizing and mixing went very well. It took one day to pulverize the existing pavement and two days to mix the CTB on each road. The county equipment on the job included one motor grader operating nearly full time, first maintaining traffic during the pulverizing stage, and then on the lay down process after mixing. Water availability is critical to the success of a CTB project, to expedite the completion and to obtain the desired strength. The county was prepared to do what was necessary to meet this requirement. There were two 3,500 gallon trucks plumbed to hook up to the mixer and another water truck on the job providing dust control and maintaining surface moisture on the mixed CTB. A fourth tanker was working between this project

Each day's run was shot with a curing seal of CSS-1 diluted with 50 percent water. The shot rate was 0.25 gallons per square yard. Load restrictions were placed on the roads and left in place for two weeks to keep the trucks off the road until it had developed more strength. We didn't think cars would be a problem, so we left the roads open to lighter traffic.

Over the years, there have been many problems with mud holes and pavement break-up on Spokane County roads. When the county reconstructs a road, we are never sure what we will find. On many of these roads, we find that muddy subgrade has been excavated and replaced with shot rock or pit run. We found oversize material on these roads, some of it as

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large as 8 inches, but it created few problems while pulverizing and mixing. It would have been a problem to lay a smooth grade with this material. However, we had anticipated that we might have this problem, and had decided to top the CTB with one to three inches of Washington State Department of Transportation specification Top Course, as needed. This would provide enough fine material to build in the proper cross fall and blade it to a smooth surface. About three weeks after the mixing and lay-down operation, we placed the gravel and compacted it to a 95 percent of maximum density.

▲ **Applying the BST**

The final stage of construction was to apply a Bituminous Surface Treatment. The surface was tested to have optimum moisture. A motor grader bladed the top one inch of top course into a wind row along one side of the road. Then the material was bladed back across the road, depositing approximately 1 1/4 inch of loose material on the surface. This material was then shot with 0.65 gallon per square yard of MC-250. The oil was allowed to penetrate the loosened material, than a layer of 1/2 inch by 1/4 inch chips was applied and rolled in using a rubber tire roller and a steel wheel roller. This was allowed to cure for approximately two weeks, before a second shot of oil was applied. This was 0.54 gallon per square yard of CMS-2 emulsion asphalt. It was blotted with chips, choked with No. 4 sand, and rolled with a rubber tire roller.

In January, an attempt was made to extract cores from the structure sections. However, the attempt failed because there was a substantial amount of coarse aggregate in the matrix, and the cement was not strong enough to hold it in place during the coring process. Recent tests with the Road Rater indicate that there has been a substantial increase in strength. In the initial evaluation there were several locations that the tests indicated softness. Although these places improved, they did not improve as much as we would have preferred. In the future, we might consider sub-excavating soft places like this and repairing them prior to the CTB treatment.

Although we had done a cold in-place recycle project back in the late 1980s, using asphalt, we had never done a CTB cold in-place recycle project. Our estimate for the project was $362,000. In comparison, this was less expensive than reconstruction using a gravel structure section, which we estimated to be $600,000, or approximately $135,000 per mile. When we completed the project and totaled the costs, we had a very pleasant surprise. Our total costs, including a third chip seal, to be shot this year, will be only $91,000 per mile, for a total cost of $400,000.

The success of this project has lead to the decision to do more CTB projects. We plan to stay with our criteria of using this product on roads that have high volumes of truck traffic. We will also schedule the projects when the roads come up on our chip seal program, thus getting the maximum life from the previous chip seal. Of course, we learned from this project, and there are some things we will do different next time. However, they will be only minor changes. The project was very successful.

What is That Stuff You Are Spraying on the Road?

By: Jack Manicke, Staff Superintendent, WSDOT

Quick facts about Magnesium Chloride and Calcium Magnesium Acetate (CMA)

- They are called anti-icers or deicers.
- They are liquid mixtures that work somewhat like antifreeze to help melt ice and snow. Under certain conditions, they may assist in reducing or avoiding ice slickened conditions on roads.
- Anti-icers may last longer and work in a broader range of conditions than sand.
- Unlike sand, there are no hidden costs after the initial application such as a need for sweeping.
- Anti-icers are easier to handle than sand in certain conditions. (Sand freezes up in truck beds and hoppers.)
- Extensive studies in the U.S. have found anti-icers to produce no negative effects on ground water, the water table, or vegetation. In addition, they don't contribute to the health risk of airborne dust particles as sand may.
- Mag-Chloride or CMA are used:

  – as anti-icing agents to help prevent ice from forming on roads,

  – as de-icing agents to help remove thin ice or snow pack from roads,

  – in combination with sanding materials, to help sand stick to snow pack better and to stay longer.

Why not just use sand?

Anti-icer, unlike sand, can be very effective to help melt or prevent black ice, freezing rain, and snow pack conditions, and it may help keep snow from firmly sticking to the pavement so that when a snow plow comes along, the snow can be easily removed. Anti-icer is not susceptible to wind blow-off conditions like sand and it may be applied ahead of time when traffic is light and before rush hours hit.

Sand may require repeated applications due to windy conditions or its being blown off the road by traffic. This means maintenance crews must stop doing other scheduled work in order to reapply it. In most areas after the winter season, sand has to be swept and hauled away for disposal or recycling, all of which adds to its cost.

Will they damage my vehicle?

Mag-Chloride or CMA may leave a film on your vehicle. Even though these materials often contain anti-corrosion additives, just about any liquid can potentially damage metals. So, it makes sense to wash your car and wheels when the weather allows.

What about the costs?

There are less expensive chemicals to use for snow and ice control, such as sodium chloride (salt) and straight calcium chloride. They are used in dozens of states, especially the Eastern states. However, these other chemicals are hard on vehicles, bridges and on the environment. Even though they are cheaper to purchase up front, they are costly when you look at the whole picture.

Mag-Chloride and CMA are good alternatives because they cause minimal damage and are generally very effective. Anti-icers and deicers have been extensively studied and tested in this country and in Canada as part of the efforts to improve highway safety. In the last few years, Washington, Idaho, Montana, Oregon, and British Columbia have worked together to develop stringent new standards for anti-icers and deicers that are appropriate for our environment and much less corrosive than the alternatives. The chemical industry has worked hard to meet those standards. And the products that have evolved have made a big difference in winter driving conditions.

There is more. . .

Air quality is the other part of the story. Airborne dust is a health risk and there are limits to the amount of dust allowed in the air we breathe. Some communities do not meet Federal Clean Air Act Standards. Since sanding materials may help contribute to the

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problem when they get crushed and become airborne from traffic, using either Mag-Chloride or CMA is one accepted method to improve the safety of winter roads while limiting such airborne dust.

How are they used?

Anti-icing: A light application of the liquid may be made to a bare or wet road before a storm to help prevent a hard bond of ice or reduce snow build up and to speed snow and ice breakup after the storm.

De-icing: The liquid is applied to remove a thin layer of snow pack or ice already on the road. It also can be effective to help melt or assist in preventing black ice and freezing rain.

Pre-wetting: Wetting traditional sanding material with anti-icer causes sand to stick to snow pack better. Keeping sand on the road is nearly impossible in some circumstances, especially in very cold weather and in cases where there is traffic at highway speeds. Anti-icer may help keep the sand from blowing to the shoulder of the road.

No Idea Too Small!
Come and share it with the rest of us!

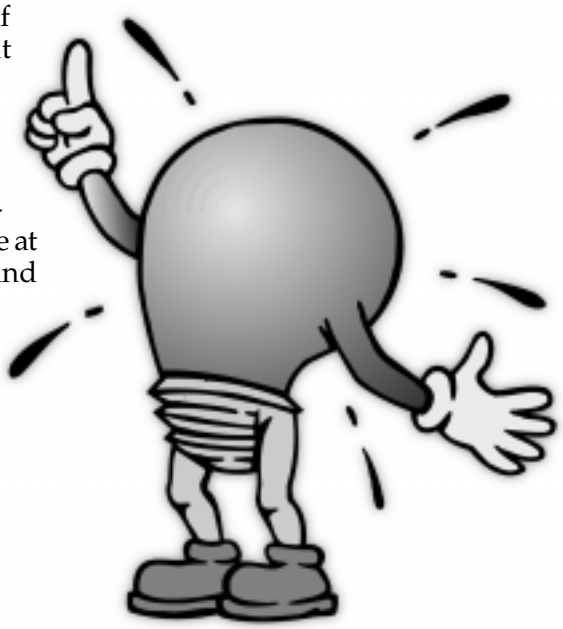
The WSDOT, WST2 Center, and FHWA are co-sponsoring the first Pacific Northwest Transportation Technology Expo at the Grant County Fairgrounds in Moses Lake, Washington, September 12-14, 2000. The purpose of the Expo is to demonstrate the leading edge technologies currently available on the market, as well as innovative "home grown" ideas for roadway operations developed by Pacific Northwest state and local agency transportation operations staff.

A major part of the Expo will be set up for demonstrations and displays of practical tools, equipment modifications, and new techniques developed and used in the field by public agencies. No idea is too small. If it works and saves you time and money, we invite you to share it with the rest of the agencies in the Pacific Northwest.

This will be one big three-day "show-and-tell" to share your ideas and see what others like you have done to be more efficient and effective.

Attendance, registration, and display space are free to public agencies. We have plenty of space. Just let us know what your innovation is and how much space you need. We'll make the arrangements to get you a site. If possible, we encourage the actual inventor to be at the display to field questions and show the functionality.

For further information and to reserve a site, Please contact Kelly Newell Conference Coordinator at (509) 335-4247 or knewell@wsu.edu



FHWA Introduces Informational Guide on Roundabouts

Reprinted from FHWA, Research and Technology Transporter — March 2000

A comprehensive informational guide for roundabouts is about to be published. The report, *Roundabouts: An Informational Guide* (RIG) covers all aspects of the practice from planning to landscaping. The table of contents is as follows:

- Chapter 1 — Introduction
- Chapter 2 — Policy Considerations
- Chapter 3 — Planning
- Chapter 4 — Operation
- Chapter 5 — Safety
- Chapter 6 — Geometric Design
- Chapter 7 — Traffic Design and Landscaping
- Chapter 8 — System Considerations

Objectives of the RIG are both educational and prescriptive. The guide provides background information on roundabouts, such as definitions and characteristics of safety and traffic operation issues. The bulk of the safety and operational benefits are based on studies conducted in Europe and Australia. It also includes information about all roadway users — automobile drivers, bicyclists, and pedestrians — with equal attention.

The guide is prescriptive in that it includes all pertinent policies and criteria by the American Association of State Highway and Transportation Officials (AASHTO), in addition to acceptable international practices. Researchers extensively and critically reviewed European and Australian practices and research publications to combine and create the best recommendations. Although guidelines and practices may vary from one country to another, a certain consensus or trend is common to most countries. When researchers could not develop a convincing recommendation, the decision was left to the discretion of the highway planners and engineers.

Well-designed roundabouts have considerable safety benefits. They reduce the number of potential traffic conflicts and reduce drivers' speed. Based on studies from other counties and the United States, there are 40 to 50 percent fewer injuries or fatal crashes reported in roundabouts than in conventional stop-controlled or signalized intersections. The safest roundabouts are those with single-lane entries.

Highway planners and designers can learn from these studies and work to reduce crash records at conventional intersections in the United States. Twenty to

25 percent of fatalities and about 35 to 45 percent of crashes involving injury occur at conventional intersections. About 100 roundabout sites have been built in the United States and roughly 150 sites are under design or construction. In comparison, the United Kingdom has built approximately 8,000, and France has 17,000 sites. Other countries, including Australia, Germany, and the Netherlands, have also constructed numerous roundabouts.

Roundabouts: An Informational Guide (FHWA-RD-00-067) will be published on FHWA's website, ***http://www.tfhrc.gov*****.** You can order a copy of the report in advance by sending a fax to FHWA Report Center at (301) 577-1421, or by e-mail, ***marl.green@fhwa.dot.gov.*** FHWA's Report Center voice number is (301) 577-0818. FHWA Divisions and Resource Centers will be receiving copies directly without having to order them.

Joe Bared, (202) 493-3314
joe.bared@fhwa.dot.gov

Good News for Local Agencies! WSDOT makes Standard Plan files available in an AutoCAD format

In response to your requests, the WSDOT Design Office has begun experimentation with providing AutoCAD DWG files for the WSDOT Standard Plans on the Internet. Local agencies often need to develop plans that are similar to WSDOT Standard Plans and having ability to use CAD files saves them a considerable amount of time. However, CAD files developed by the WSDOT are typically created in MicroStation and are not fully compatible with AutoCAD that is widely used by the local agencies. Although MicroStation files can be exported as AutoCAD files, the conversion is not always exact. So it is incumbent on the user working with the drawing to ensure that all of the details are correct. It is also important to realize that anytime a CAD file is used or modified, the designer is responsible for the entire content of the plan and must affix the appropriate PE stamp.

Currently there are a limited number of Standard Plans available in the DWG format. Although there are no plans to convert every existing Standard Plan to AutoCAD format at this time, there is a process in place to convert them all over time. As each Standard Plan is revised or a new one created, an AutoCAD file will be added to the website in along with the MicroStation and Adobe PDF files.

Where are these CAD files located? You can find them at: **http://www.wsdot.wa. gov/eesc/cae/std_plan/DSG%20New%20Std%20Plans.htm**

From their website you can also easily see what CAD files are available from other states. If you click on the button "More CAD Sites," it will take you to a page containing a map. From there it is simply point and click.

Since this image map contains links to each of the states DOT pages and home pages, it is also a handy tool for other searches as well.

If you want to go directly to the map, the URL is: **http://www.wsdot.wa. gov/eesc/cae/std_plan More%20CAD% 20Sites.htm**

The T2 Center Welcomes Wendy Schmidt

We are pleased to introduce our newest member to the Technology Transfer team, Wendy Schmidt.

Wendy is our new T2 Assistant and your contact to register for classes, check out a video tape, or provide you with general T2 information. Formerly of Okanogan County, Wendy brings over 21 years experience in public works at the county level. We look forward to the additional dimension her experience and skills bring to the Center.

Wendy can be reached at (360) 705-7386 or e-mail **schmidw@wsdot.wa.gov**.

Roger's Technology Toolbox

GIS/GPS more than alphabet soup

By: Roger Chappel

Many people today seem to put GIS (Geographic Information Systems,) and GPS (Global Positioning System) into the same alphabet soup. In fact, they serve very different functions. In this article I hope to clear the water a little and show how these uniquely different systems work very well together.

In the last article we talked about some of the differences between types of GPS receivers. I identified four general types of receivers:

- Navigation Grade
- Mapping or Inventory Grade
- Survey Grade
- Specialty and Military Grade

In this article I would like to narrow our focus on "mapping or inventory grade" GPS receivers, and their role in a GIS. This is one of the fastest growing applications of this new technology and it carries with it the most profound impacts on how we will manage corporate data in this new millennium.

Whether you are managing a sign inventory, a striping log, or a wetland, GIS may be just the tool for you and GPS may be the key that will help you to use it.

Whether you are managing a sign inventory, a striping log, or a wetland, GIS may be just the tool for you and GPS may be the key that will help you open the door to the world of GIS.

Before we dive in, I am going to indulge myself in a brief tirade on what I call "technobabble." I find that one of the most difficult elements of applying new technology is understanding the terminology.

Words should clarify and communicate the concepts involved in the technology. All too often they seem to be abstract, ill chosen, or poorly adapted from another field. One of the problems is that these systems are so new and dynamic that the words with the exact meaning of the new concepts don't always exist. Words are then created or borrowed from other disciplines that describe similar concepts and their definitions are expanded on. As a result, words for the new technology may have a subtle, or not so subtle, difference from older established fields. Add to this the dynamic state of the technology itself and you have a real potential for miscommunication between disciplines and individuals unfamiliar with the new technology. At times, it is like learning another language where the meaning of the words changes as subtly as dialects do within a language. Words such as "geospatial coordinates" to a geodesist may paint a very different picture in the mind of a cartographer or GIS manager. For example, as you read this article you will encounter words that will be defined by the surrounding text. Your agency may use different terminology to describe similar concepts and functions.

Another problem is that you won't find most new technical words like geospatial in a regular dictionary, so there isn't an easy source of standardized definitions.

The world of GIS is a melting pot of various disciplines, cultures, and data types. The common language is geospatial coordinates (XY&Z (coordinate geometry), i.e. latitude, longitude and elevation).

I mention the topic of technobabble in hopes that it will alert you to its existence and the ramifications that multiple definitions of terminology can have as you encounter the different dialects of technobabble within your agency.

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So, what does all this GIS stuff have to do with GPS?

First, we need to answer the question, what is a GIS (Geographic Information Systems?)

In it's simplest terms, a GIS is an electronic map with information on it. If you were to plot an outline of the State of Washington on a piece of paper and place it on a table, you would have defined a geographic area. Next, assume you were to take sheets of clear plastic with information on them about this

geographic area and lay them on top of the map in layers, one on top of the other. Information on each subsequent layer is displayed in three format types, points, lines and polygons, depending on the type of data represented.

For example: Some layers may have topographical information showing hills, valleys, bodies of water, etc. Other layers may have county boundaries, tribal reservations, forests or wetlands. These enclosed shapes, or areas, are commonly referred to as "polygons" (a geometric plane consisting of three or more sides).

Other layers may have linear representations of roads, striping logs, railroads, rivers, streams, etc. These are referred to as "lines."

Still other layers may have "point" information such as cities, airports, signs, culverts, and mileposts.

All information that is placed on a map (geographic) must be some type of point, line, or polygon.

Instead of using paper and plastic layers, a GIS is a computerized "system" that helps you store, manage, analyze and present your geographic information electronically.
Thus the name GIS is a compound acronym built from: geographic (map or area), information (layers of data), and the system (the computerized software system).

The glue that holds all these layers of information together and orients them properly to themselves is georeferencing. Georeferencing is a referencing system based on a X,Y and sometimes Z (length, width, height) coordinate system. For example: longitude, latitude, and elevation. I say sometimes "Z", because most GIS's currently operate in two dimensional space not 3 dimensional, but that is a topic we will discuss in subsequent issues.
To assist you in understanding GIS terminology, the Association for Geographic Information has a GIS dictionary and other tools (i.e., acronym list) on their web site at:
http://www.geo.ed. ac. uk/agidict/welcome.html

For example they define georeference as:
"Georeference: To establish the relationship between page coordinates on a map and known real-world coordinates."

So, what makes the GIS "electronic" map more than just a "dumb" graphic or pretty drawing on a piece of paper?

Simple. Someone has taken these graphical elements and other information related to the map and referenced them to locations in the real world. What was once an artistic representation of the real world, is now a "smart" map because it knows where in the real world it's layers are located geospatially. All the layers in your GIS are glued together because they all represent the same geographic locations. This, in effect, takes all the layers of information and places them over each other so all common points are in alignment. For example, the point that a river intersects with a roadway (on the river layer), now matches the point that the roadway intersects the river (on the roadway layer), and both those points match the actual location in the real world.

A GIS can "speak" other languages besides XYZ, such as LRS (linear referencing system), but again the common language to both is georeferencing.

In a GIS you can turn the layers on and off to help display and analyze your data in various combinations and in a common format. It also provides a common language to share your data with others and to analyze your data against factors that are hard to see in a tabular format, such as a database.

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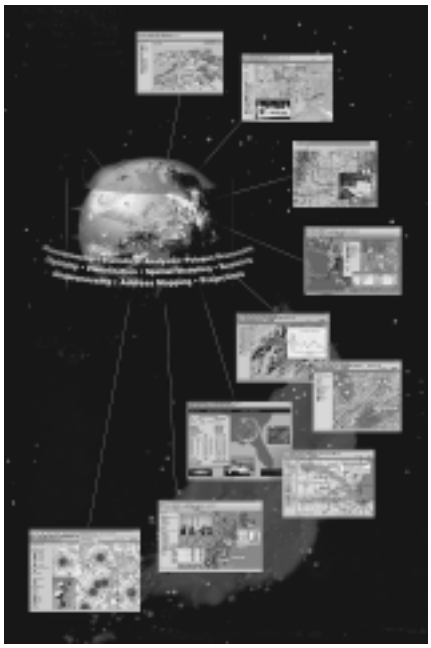
For example: If I have a stretch of roadway (line) that quickly deteriorates after paving and I bring that roadway up in a GIS, I can place readings from a deflectometer on top of it (point data.) This information may lead me to turn on the soils and wetlands layer (polygons) underneath it. Since these lines, points, and polygons are all georeferenced to the same geospatial location, I can quickly align all the information and analyze the relationships between them. Now as I analyze my layered data, I discover that the roadway is failing because of the surrounding environment, not because of the materials that were used in the paving construction. This is only one of many possible applications. I am sure that you can see the value of such a system, the possibilities are unlimited.

So what does all this GIS stuff have to do with GPS?

The answer, nothing and everything. It depends on the type of data you are collecting and how your data will ultimately be used.

In its simplest definition, GPS is a satellite-based measuring system. As a GIS can be described using layers of paper and plastic, GPS can be characterized as a high tech three dimensional measuring tape. If you pulled 12,600 miles of tape from four tape measurers in geosynchronous orbit above the earth, they should intersect at a measurable location on the surface.

One system specializes in organizing and analyzing data, the other specializes in the ability to locate data. You can use GPS as a stand alone system to locate "things" (points, lines and polygons,) quickly, easily and very accurately depending the equipment and procedures you use. So in short, each system can function independently of one another, but when integrated they offer a very powerful combination.



In fact, many of the inventory grade GPS receivers today integrated some of the features found in a GIS. This also seems to be a source of confusion to many today. Though these hybrid GPS systems have some of the functionality of a GIS, they lack the power and the full functionality of a GIS work station. On the other hand, even though the georeferencing of the base maps is getting more accurate all the time, a work station will never have the mobility and abilities that a GPS receiver has.

Some of the differences identified between GPS receivers in the last article, were accuracy and functionality. An example of the basic "navigation grade" or recreational usage of GPS would be: "I found location X,Y,Z and I can return to location X,Y,Z whenever I want to." Navigation alone makes GPS a very handy tool.

The next step in using GPS is "mapping" or "inventory grade" usage. Now that you can locate XYZ you may want to store information (attributes) that describes the things you have located. For example: I am at location XYZ, the data element I want to locate and describe is a box culvert. Most software will even allow you to break this element down even further to "attributes" about it, i.e. made of reinforced concrete, etc.

It is at this point that a decision needs to be made. If you will need to share, analyze, or present this data, then you will want to collect and store the data in a format that a GIS will recognize. If not, and the data will be used solely as a stand alone application for internal purposes without the need of a GIS, then a simple database may be the most appropriate mechanism for storage and retrieval of your data.

There are several ways to accomplish this. Fortunately, GPS and GIS already speak the same language of "geospatial coordinates." So, communication between the two systems is relatively easy.

For this particular journey I would like to look at using GPS to gather "point data" for a GIS. The reason for this is that it is

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the easiest path to travel. Data involving lines and polygons can get fairly complex. If you are using GPS to gather information about things that are going to be represented as lines or polygons, I would recommend involving your GIS manager and possibly a cartographer in your project. Even "point" data can become tricky at times. For example:
A city at one scale may be a point on the map, but as you "zoom in" that point may cover a large area and become a complex polygon.

Knowing a little bit about what map scales are available for you to use to plot your data on is important. With GPS we have at our disposal a tool that can quickly and accurately identify where in the world something is located. Depending on the type of receiver you use and the procedures you follow, the data you collect may be more accurate that the map that you place the information on.

When you start to collect your data you will also need to know what coordinate system to use, such as lat/lon in decimal degrees, or whether you will use state plane coordinates with NAD 83 or NAD 27 as your datum. It is best to involve your GIS support people in the early stages of your project. This will help resolve these types of formatting issues before you have a heavy investment into your data collection.

...data collection may very well be the most costly part of your project

Your data collection may very well be the most costly part of your project, so my recommendation is to test, test, and test a sample again prior to full scale collection. I've seen to many projects full of either useless or difficult to use data because they were not fully evaluated prior to implementing the collection process. This could have been avoided by simply working together and testing the results before full production. Making changes after you have started data collection results in duplication of effort (collecting the same data multiple times) and data disparity (similar objects described or attributed differently), resulting in a lot of wasted time and money.

In the next issue I will cover confusing issues such as datums and ellipsoids. 'Til next time, work on your technobabble, surround yourself with geodesists, surveyors, GISers and cartographers. Most of them are really great people if you can figure out what they are talking about.

For past issues of the T2 Bulletin: ***http://www.wsdot.wa.gov/TA/T2Center/T2Bulletin-archives/T2Bulletin.html***

NWPMA News
"Working Together for Better Pavements"

A Word From the Chair

With the holiday season behind us and spring in the air, it's time for some of us to finalize updates to our road logs with 1999 activities and prepare for a new millennia of fun and excitement.

Reflecting back on the impact that the NWPMA has had with its members in developing effective pavement management systems is very commendable. It would be hard to conceive what it would be like if this Association did not exist.

I would like to thank Dave Shepard, Clark County, Callene Abernathy, Kitsap County, and Vicki Griffiths, Skagit County, for their past years service and dedication as officers of our Association.

I would also like to give special thanks to the E-Board members for their devotion and perseverance, for they are the moral fiber from which the backbone of this Association was forged and remain the motivating force behind our existence. Thank you all once again, you are very much appreciated.

We had a successful Spring Quarterly Conference with attendance from across three states and representation from both cities and counties. The agenda was formatted to include topics that were suggested at your last chapter meetings and were well received by the attendees.

This Conference was our usual informal get-together (black tie not required) and information exchanged at this Conference was priceless as always. There were several interesting technical subjects presented along with open forum discussions. I hope more of you can make it next year when we go to Couer d'Alene, Idaho. Please plan on attending.

Larry Frostad,
Island County

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2001 Spring NWPMA Conference Scheduled

The NWPMA Spring Conference has been scheduled for May 2001 in Coeur d'Alene, Idaho. As a part of the Conference the WST2 Center is planning to provide a one-day pre-conference workshop. If you have a specific topic you would like to have presented, please contact Dan Sunde, Director WST2 at SundeD@wsdot.wa.gov or (360) 705-7390.

Watch the T2 Bulletin for details on the conference and the workshops as they develop.

Proposed NWPMA Charter Revision Posted

The Association has evolved over the last few years with the additions of Idaho and Oregon and modifications of Chapters. As a result, the current Charter has grown out of date and no longer reflects the way the Association is actually functioning. A revised NWPMA Charter was reviewed and discussed at the 2000 Spring Conference in Bend Oregon, April 14. It was agreed to present the new Charter for a vote of approval at the 2000 Annual Pavement Management Conference in Portland this fall.

A copy of the final draft is available for review. You can find a copy posted on the NWPMA web page under "Purpose" page at:

http://www.wsdot.wa.gov/ta/T2Center/Mgt.Systems/PavementTechnology/purpose.html

If you are unable to access the webpage you can request a copy from one of the E-Board members or Dave Nichols, Thurston County, at nichold@co.thurston.wa.us or (360) 754-3355 Ext: 7817.

Southeast Washington Chapter Forming

Lee Rawlings of the City of Kennewick is forming a new chapter of the NWPMA for agencies in the vicinity of the tri-cities. If your agency is interested in learning more about PMS, PMS training, keeping up with current resources available to assist you in managing your pavements, and networking with your counterparts in your region, please contact Lee at (509) 585-4309 or e-mail: leerawlings@ci.kennewick.wa.us

Learn from others, pass your experience on to them, and make your pavement program more efficient.

We're On Line!

Check us out at: ***http://www.wsdot.wa.gov/TA/T2Center/Mgt.Systems/PavementTechnology/nwpma.html***

Can a BST be used as a prelevel?

Jeff Uhlmeyer, P.E., WSDOT Pavement Design Engineer

BST as prelevel for minimal rutting should not be a problem, as long as you can control the operation and take extra care.

WSDOT Maintenance has used this technique but has taken extra precautions to ensure control of the oil and placement of BST. If you get too much oil in the rut or do not control the placement of the chips so they are contained within the ruts, your problem may not be solved and rutting may still result. The key is to ensure proper placement of oil and aggregate. It's also important that the aggregate size matches the depth of the rut.

Control can be difficult during a contract operation because the contractor may not be willing to take the extra precautions. It is likely that the contractor may request a change order to replace the BST with ACP if BST prelevel is specified.

MUTCD Millennium Edition

by Linda L. Brown, FHWA

The Federal Highway Administration, Office of Transportation Operations, is in the process of a major rewrite of the Manual on Uniform Traffic Control Devices (MUTCD). The MUTCD contains the criteria used by traffic engineers and transportation officials to communicate safe driving messages to the roadway users. This manual contains the standards and guidance for the design and use of signs, pavement markings, traffic signals, and other traffic control devices. The last time that the MUTCD was rewritten in its entirety was over 20 years ago. Innovative technology, roadway developments, new traffic control device applications, and complicated technical text have made it necessary to reexamine the information in the current 1988 edition of the MUTCD. A major rewrite and reformat effort of this manual has been underway since 1995 to incorporate technology advances in traffic control device application and to improve the overall organization and discussion of the contents in the MUTCD to make it clearer and more user friendly.

The MUTCD is incorporated by reference in 23 CFR part 655 and all changes to the MUTCD must be made through the Federal Register rulemaking process. This process allows all interested persons to provide comments on the proposed changes. The FHWA published Federal Register notices of proposed amendments for all of the following parts of the MUTCD:

- Part 1 - General Provisions
- Part 2 - Signs
- Part 3 - Markings
- Part 4 - Signals
- Part 5 - Traffic Control Devices for Low Volume Rural Roads (New)
- Part 6 - Traffic Control for Construction and Maintenance
- Part 7 - Traffic Control in School Areas
- Part 8 - Traffic Control at Highway-Rail Grade Crossings
- Part 9 - Traffic Control for Bicycle Facilities
- Part 10 - Traffic Control for Light-Rail Transit (New)

FHWA has also published a notice of proposed update information for Parts 1, 3, 4, and 8. Public comments for all parts of the MUTCD must be received by June 2000 at which time FHWA will review and summarize the comments and prepare a Final Rule position which will be published in the Federal Register in December 2000.

The FHWA realizes the critical role public awareness and education play when introducing new or revised products to our customers and partners. FHWA also realizes that the new policies and technologies that are implemented will have a strong impact on citizens and industries well into the 21st century.

The FHWA goal is to expand its traditional network and audience to include others such as motor vehicle departments, driver's education classes, law enforcement personnel, and tourist agencies, community civic leaders, and emergency response providers.

In an effort to create more public awareness of the MUTCD, the FHWA is publishing the Millennium MUTCD in several media format: traditional hard copy, CD-ROM and Internet.

The Federal Register notices and the proposed text are available at the following Internet locations: The Federal Register home page is ***http://www.nara.gov/fedreg and the MUTCD home page is http://mutcd.fhwa.dot.gov.***

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The FHWA is expanding its web site to include electronic briefing presentations which provide an overview of the proposed MUTCD changes and a database management program which can be used to research historical and background information on various MUTCD requests for changes, experimentation, and interpretations. Other features will be added in the future as FHWA endeavors to make the MUTCD web site a "One Stop Shop" for information concerning traffic control devices.

FHWA hopes that you will share the MUTCD web site with others who may have an interest in optimizing performance and highway safety through the use of traffic control devices.

. . .Waste Not and Make School Signs Stand Out, Too!

Reprinted from Florida T2 Technology Transfer Quarterly — August 1999

Seminole County has a new idea that is saving them almost $2,000 for every 300 signs, and since they have about 850 signs to replace, this is a substantial savings!

This year they started replacing their school/pedestrian crossing signs with ones made from the newly approved 3M Yellow/Green sign material. The new signs come in large squares and, after cutting, there are two good-sized triangles of the bright green material left over.

Since the material costs $1,920 for a 30-inch by 50-yard roll, they wanted to find a use for the left-overs — and ended up making their school speed limit signs more visible in the process. They have simply pieced the two left-over triangles together to make a decal for the top of the school speed limit sign.

The left-over material was enough for 300 decals! How's that for ingenuity?

▲ **Jose Cordero with the County's new school speed limit sign. The word "school" is made of left-over 3M Yellow/Green sign material from school/pedestrian crossing signs.**

WSDOT Library Your info Link

Helpful tips and other resources from the WSDOT Transportation Library

Claudia Devlin, WSDOT Librarian

Did you know that both Tables of Contents and abstracts for the American Society of Civil Engineers' (ASCE) journals from 1999 to the present are available on-line? The journals are as follows:

- Journal of Aerospace Engineering
- Journal of Architectural Engineering
- Journal of Bridge Engineering
- Journal of Cold Regions Engineering
- Journal of Composites for Construction
- Journal of Computing in Civil Engineering
- Journal of Construction Engineering and Management
- Journal of Energy Engineering
- Journal of Engineering Mechanics
- Journal of Environmental Engineering
- Journal of Geotechnical Geoenvironmental Engineering
- Journal of Hydraulic Engineering
- Journal of Infrastructure Systems
- Journal of Irrigation and Drainage Engineering
- Journal of Management in Engineering
- Journal of Materials in Civil Engineering
- Journal of Performance of Constructed Facilities
- Journal of Professional Issues in Engineering Education & Practice
- Journal of Structural Engineering
- Journal of Surveying Engineering
- Journal of Transportation Engineering
- Journal of Urban Planning & Development
- Journal of Water Resources Planning & Management
- Journal of Waterway, Port, Coastal & Ocean Engineering
- Natural Hazards Review (NEW)
- Practice Periodical of Hazardous, Toxic, & Radioactive Water Management
- Practice Periodical on Structural Design and Construction

In addition, the Civil Engineering Database (CEDB) provides easy bibliographic access to all ASCE documents published since 1973. Documents includes journals, conference proceedings, books, standards, manuals, magazines, and newsletters. The database can be searched by a variety of fields with Search Tips and Techniques and a Keyword List provided for additional search help.

All of the above can be reached by clicking on the following URL: **http://www.pubs.asce.org.**

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This order form is available on the WSDOT Homepage at: http:www.wsdot.wa.gov/TA/T2Center/T2PUBS.htm

Check the items you would like to order.

- ❑ 1999 Audio Visual Catalog, T2 Center
- ❑ Asphalt Seal Coats, WST2 Center (1999 Reprint)
- ❑ Basic Metric System, WSDOT
- ❑ Evaluation of Automated Pavement Distress Data Collection Procedures for Local Agency Pavement Management, Texas A&M, WSDOT, ODOT, 1996
- ❑ Family Emergency Preparedness Plan, American Red Cross, et al.
- ❑ Financing Federal Highways, FHWA, 1999.
- ❑ Fish Passage through Culverts, FHWA, USDA, 1998
- ❑ Fly Ash Facts for Highway Engineers
- ❑ Getting People Walking: Municipal Strategies to Increase Pedestrian Travel, Rhys Roth, Energy Outreach Center
- ❑ Gravel Road Test Sections Insulated with Scrap Tire Chips, CRREL 94-21
- ❑ A Guide to the Federal-Aid Highway Emergency Relief Program, USDOT, June 1995
- ❑ A Guide for Local Agency Pavement Managers, NWT² Center, 1994
- ❑ A Guidebook for Residential Traffic Management, NWT² Center, 1994
- ❑ A Guidebook for Student Pedestrian Safety, KJS, 1996
- ❑ Highway/Utility Guide, FHWA 1993
- ❑ Impact of Excavation on San Francisco Streets, The, September 1998
- ❑ Improving Highway Safety at Bridges on Local Roads and Streets, 1998
- ❑ International State-of-the-Art Colloquium on Low-Temperature Asphalt Pavement Cracking, CRREL
- ❑ Local Agency Pavement Management Application Guide, NWT² Center, 1997
- ❑ Maintenance of Aggregate and Earth Roads, WST² Center (1994 reprint)
- ❑ Manual of Practice for an Effective Anti-icing Program: A Guide for Highway Winter Maintenance Personnel, FHWA, 1996
- ❑ New Generation of Snow and Ice Control, FHWA
- ❑ Pavement Surface Condition Field Rating Manual for Asphalt Pavement, NWPMA, WSDOT. 1999
- ❑ Pedestrian Facilities Guidebook, WSDOT ($12.00 + postage outside Wasington State)
- ❑ Pothole Primer — A Public Administrator's Guide, CRREL, 1989

❑ Rating Unsurfaced Roads, A Field Manual for Measuring Maintenance Problems, CRREL
❑ Recommendations to Reduce Pedestrian Collisions, WSDOT, December 1999
❑ Redevelopment for Livable Communities, Rhys Roth, Energy Outreach Center
❑ Snow Fence Guide, SHRP - H - 320, NRC, 1991
❑ State-of-the-Art Survey of Flexible Pavement Crack Sealing Procedures in the United States, CRREL, 1992
❑ Superpave System – New Tools for Designing and Building More Durable Asphalt Pavements, FHWA
❑ Traffic Calming: A Guide to Street Sharing
❑ Unsurfaced Road Maintenance Management, CRREL 1992
❑ Use of Scrap Rubber in Asphalt Pavement Surfaces, CRREL 91-27
❑ W-Beam Guardrail Repair and Maintenance, FHWA

Workbooks and Handouts From T² Center Workshops

❑ Access Management Guidelines for Activity Centers, NCHRP Report 348, TRB/NRC, 1992
❑ Construction of Portland Cement Concrete Pavements, FHWA/NHI 1996
❑ Geosynthetic Design and Construction Guidelines, FHWA/NHI 1995
❑ Handbook for Walkable Communities, by Dan Burden and Michael Wallwork
❑ Historic and Archeological Preservation: An Orientation Guide, FHWA/NHI
❑ Planning and Implementing Pedestrian Facilities in Suburban and Developing Rural Areas, TRB
❑ Maintenance Welding Techniques and Applications, Tom Cook, April 1991

Self-Study Guides

The following noncredit self-study guides are available through WSDOT Staff Development and can be obtained from the T2 Center. An invoice will be sent with the books.

❑ Advanced Surveying, $20
❑ Basic Surveying, $20
❑ Contract Plans Reading, $25
❑ Technical Mathematics I, $20
❑ Technical Mathematics II, $20

Computer Programs

The following computer programs may be downloaded from the Internet at: ***http://www.wsdot.wa.gov/TA/Operations/Environmental/Soft.htm***

Design Cost Estimate. A software database program that calculates cost projections based on standard items.

Materials Approval Tracking. A software program designed to track materials data, need, status, and approval of any materials sampling and documentation needed for approval.

HyperCalc. A shareware utility for converting between metric and English units.

Force Account Macros. A series of ready-made Excel spreadsheets and macros to save you time on daily force account calculations and reports, including wage and equipment rates.

APWA CAD Symbol Standards and Menus. A public domain program of standard AutoCAD symbols developed by the Washington Chapter of APWA for use with AutoCAD release 14. The program may also be downloaded at http://users.ap.net/~fredlee

Microsoft Access Runtime Program. Assists in running the Materials Approval Tracking and Design Cost Estimate Program.

UTEC System. A software program consisting of a main menu designed to provide a record base for identifying street locations within an agency.

Opportunities to Enhance Your Skills

For more information, contact the training provider listed in the box, for each section. For additional training needs contact the Washington State T2 Center

Washington State T2 Center
Contact Laurel Gray, Training Coordinator
(360) 705-7355, grayl@wsdot.wa.gov
Wendy Schmidt, T2 Assistant (360) 705-7386, schmidw@wsdot.wa.gov. Fax: (360) 705-6858
http://www.wsdot.wa.gov/TA/T2Center/TRAIN2.htm

Pavement Condition Rating Workshops - 2000
June 27-28, Tacoma. Instructor: Paul Sachs. **Fee: $45.**

Collision Reporting System (CRS) Training
June 29, Instructor: John Bean, UTEC, FREE Conference Room , WSDOT Kent Maintenance Facility, West Valley Highway, Kent.

This is a one-day workshop on how to use the software program, CRS, for collision data storage, reporting and analysis. There are limited seats available, so early registration is encouraged. For additional information on the course content, please contact Ed Lagergren at LagergE@wsdot.wa.gov or (360) 705-7986.

Coming this Fall:
Advanced Biological Assessments for the ESA

WSDOT, Staff Development
Local Agencies should contact Laurel Gray in the T2 Center for information
(360) 705-7355
email grayl@wsdot.wa.gov

Intersection Analysis Using SIDRA
July 12-14, 2000, Seattle. Instructor: Rahmi Akcelik and Mark Besley of Akcelik & Associates, Australia. $450. This course combines lectures and hands-on workshop sessions to teach participants how to effectively utilize SIDRA and how to apply and interpret results from the model. SIDRA can analyze the operation of all types of intersections including roundabouts, signals, stop control, and yield controlled. For traffic engineers involved in operational analysis of intersections.

Prerequisites: Familiarity with the SIDRA package and basic knowledge of the SIDRA input method. A general familiarity with traffic engineering methods and basic knowledge of intersection capacity concepts. Basic skills in MS Windows use.

TRANSPEED, University of Washington
Contact Julie Smith
(206) 543-5539, fax (206) 543-2352
http://www.engr.washington.edu/epp
jsmith@engr.washington.edu
Select "Transpeed"

Course participants will earn CEUs for each course completed. The CEU is a nationally recognized measure of participation in non-credit continuing education programs which meet established criteria for increasing knowledge and competency.
Prices shown are for local agencies/all others.

Culvert Repair and Rehabilitation
June 13-14, Lacey. $180/$360.

Basic Highway Capacity Analysis for Engineers and Planners
July 12-14 (this is a change in date.), Seattle. $220/$420.

Managing Project Delivery
August 9-11, Seattle. $750/$950.

Basic Roadway Geometric Design
August 21-23, Seattle. $220/$420.

Traffic Engineering Operations
August 23-25 (this is a change in date.), Vancouver, $250/$450.

Advanced Highway Capacity Analysis for Engineers and Planners
August 29-31 (this is a change in date.), Seattle. $220/$420 (plus $95 for laboratory/materials fee).

Bridge Foundation Design
Date TBA, Fall, 2000, Seattle

Roundabout Design Concepts and Guidelines
Date and location TBA, Fall 2000

Manual on Uniform Traffic Control Devices (MUTCD)
Date TBA, Fall 2000, Seattle

University of Washington
Professional Engineering Practice Liaison (PEPL) Program
(206) 543-5539, fax (206) 543-2352
http://www.engr.washington.edu/epp
Select "PEPL"
UW-epp@engr.washington.edu

To register for a course, go to the **On-Line Registration Form** or call Engineering Professional Programs at (206) 543-5539.

Cold Regions Engineering Short Course
August 3-7, November 2-6, Seattle.

Quaternary and Engineering Geology of the Central and Southern Puget Sound Lowland
September 7-9, $425/$455.

Stormwater Treatment: Chemical, Biological and Engineering Principles
September 12-13, Vancouver, WA. $495/525.

Stormwater Treatment by Media Filtration
October 12-13, $515/$545.

Design and Retrofit of Culverts for Fish Passage in the Northwest
October 18-19, Spokane. $445/$475.

How to Successfully Use Value Engineering in Capital Projects
November 16 -17,. $375/$405

Construction Site Erosion and Pollution Control
December 12-13 (tentative) Portland, OR. $545/$575.

Stormwater Treatment: Chemical, Biological and Engineering Principles
January 24 - 25, $495 (early registration)/$525

Alternative On-Site Stormwater Management Techniques
March 20-21, 2001. Seattle.

University of Washington
Engineering Professional Programs (EPP)
(206) 543-5539, fax (206) 543-2352
http://www.engr.washington.edu/~uw-epp/
Select "Course Calanders"

System Safety and Reliability Analysis
July 10-20

Automotive Fire Investigation: Methods and Tools
September 13-14.

Website Design: Principles and Practice
September 14-15.

Drilling and Blasting Techniques for Construction and Quarrying
February 5-9, 2001.

Engineering Exam Prep Courses
Mechanical Engineering Refresher
September 7 - October 17.

E.I.T. Fundamentals Refresher Course
September 11- October 18.

Civil Engineering Refresher
September 12 - October 17, Seattle.

Department of the Navy
Civilian Human Resources
Human Resources Service Center NW
3230 NW Randall Way
Silverdale, WA 98383
(360) 315-8014 or (360) 315-8148

HazCat Chemical Identification Workshop
June 26-29, Silverdale. $800. Contact Ruth Childers to register. This class is designed for the primary responder who must make decisions on the scene, often without access to a chemist, and those personnel who initiate investigation of potentially hazardous wastes and materials.

Please continue to next page ➥

Conferences and Meetings

UTEC Meeting
June 8, 2000, 9:30-3:00, WSDOT Kent Maintenance Facility. Topics: Millennium Edition of the MUTCD and Target 0. Call Ed Lagergren at (360) 705-7986 for information.

Association of Washington Cities Annual Conference
June 19-23, 2000 Spokane.
Call AWC at (360) 753-4137 for information.

Fifth International Conference on Managing Pavements
August 11-14, 2001, Seattle.

Pacific Northwest Transportation Technology Expo "2000 Technology on Parade"
September 12-14, 2000, Grant Co. Fairgrounds, Moses Lake, WA. Free. For all engineers, superintendents, supervisors, and technicians involved with transportation construction, maintenance, and operations. Three days of demonstrations and displays of the latest tools, materials, and services to make your maintenance and operations dollars go farther. See how current research projects can help you do your work better with practical information you can apply today. For information call:
Dan Sunde (360) 705-7390, sunded@wsdot.wa.gov or
Clay Wilcox (360) 705-7861, wilcoxc@wsdot.wa.gov.

American Public Works Association Washington State Chapter Fall Conference
September 26-29, 2000, Longview/Kelso area. Call Bob Gregory (360) 577-3376 for information.

Road and Street Maintenance Supervisors' School
East: October 3-5, 2000; West: December 5-7, 2000. For further information contact WSU's Conference and Institutes at (509) 335-3530.

Northwest Pavement Management Association Conference
October 9-12, 2000, Columbia Doubletree, Portland, OR

39th Annual Idaho Asphalt Conference
Thursday, October 19, 2000, Moscow, Idaho.
For information contact the University of Idaho's Conferences and Events at (208) 885-6662.

Phone Numbers

Washington State T2 Advisory Committee

Walt Olsen, Chairman, County Engineer
Pend Oreille County, (509) 447-4513

Gary Armstrong, Public Works Director
City of Snoqualmie, (425) 888-5435

Phil Barto, Maintenance Engineer
Spokane County, (509) 477-7429

Wil Brannon,
Traffic Operations Supervisor/WASP
Pierce County, (253) 531-6990

Joe Bonga, Road Construction/Maint.
Bureau of Indian Affairs
(503) 231-6712

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City of Leavenworth/APWA
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County Road Administration Board
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South Zone Engineer/USFS
(509) 653-2205 ext.261

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(253) 798-2953

Jack Manicke, Staff Superintendent
Olympia Service Center, WSDOT
(360) 705-7852

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Whitman County/EWCRS
(509) 397-6209

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ENTRANCO, APWA
(360) 709-0301

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(206) 296-8100

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Association of Washington Cities
(360) 753-4137

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Fax
(360) 705-6858

T2 Web Site
www.wsdot.wa.gov/TA/T2Center/T2hp.htm

Toll Free Training Number
1-800-973-4496

Washington State Technology Transfer Center
WSDOT-H&LP Service Center
P.O. Box 47390
Olympia, WA 98504-7390

www.wsdot.wa.gov/TA/T2Center/T2hp.htm

T2 Bulletin

A Newsletter of the Local Technical Assistance Program (LTAP)

Issue 66, Spring 2000

Published by:
WSDOT Highways & Local Programs Service Center
Washington State Technology Transfer Center
310 Maple Park Ave. SE
PO Box 47390
Olympia, WA 98504-7390

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Produced by:
T2 Bulletin
A Newsletter of the Local Technology Assistance Program (LTAP)

The Local Technical Assistance Program (LTAP) is a national program financed by the Federal Highway Administration (FHWA) and individual state transportation departments. Administered through Technology Transfer (T²) Centers in each state, LTAP bridges the gap between research and practice by translating state-of-the-art technology into practical application for use by local agency transportation personnel.